PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B29C 41/36, 41/04

A1

(11) International Publication Number: **WO 99/32270**

(43) International Publication Date: 1 July 1999 (01.07.99)

(21) International Application Number: PCT/GB98/03758

(22) International Filing Date: 18 December 1998 (18.12.98)

(30) Priority Data:
9726715.7 19 December 1997 (19.12.97) GB

(71) Applicant *(for all designated States except US)*: ROTOSPEED LIMITED [GB/GB]; 13 Trinity Centre, Park Farm Industrial Estate, Wellingborough NN8 2ZB (GB).

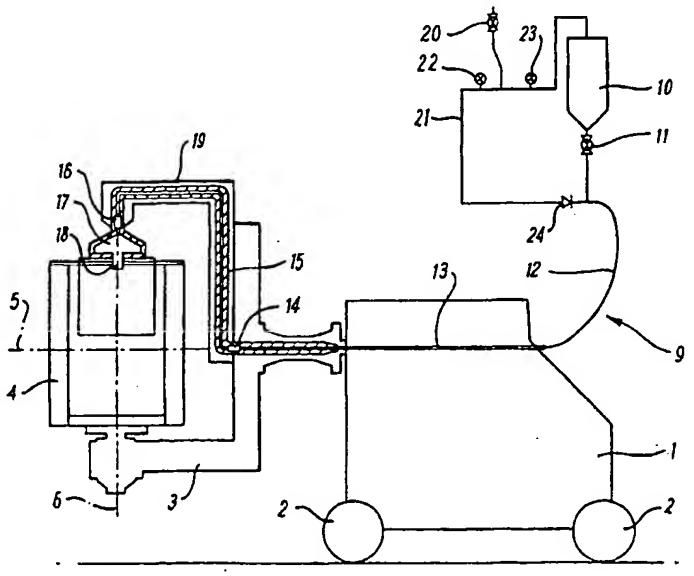
(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: CRAWFORD, Robert, James [GB/GB]; 36 Edenticullo Road, Hillsborough, County Antrim BT9 6JG (GB).

(74) Agents: DOWNEY, William, Gerrard et al.; Wilson Gunn M'Caw, 41–51 Royal Exchange, Cross Street, Manchester M2 7BD (GB).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: METHOD AND APPARATUS FOR FEEDING MATERIAL INTO A ROTATING MOULD



(57) Abstract

Apparatus for rotational moulding comprises a feed hopper (10) pressurised by a compressed air supply (20) from which moulding powder may be fed under pressure via a line (12) to a mould (4). The feed line includes rotatable joints (14 and 16) which enables the mould to be rotated about two perpendicular axes, while material to be moulded is being fed to the mould. The apparatus and associated method reduce risk to operatives from inhalation of material, facilitate production of multilayer products and enable faster cycle times.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania
AM	Armenia
AT	Austria
AU	Australia
AZ	Azerbaijan
BA	Bosnia and Herzegovina
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
BY	Belarus
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CN	China
CU	Cuba
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
GE	Georgia
GH	Ghana
GN	Guinea
GR	Greece
HU	Hungary
IE	Ireland
IL	Israel
IS	Iceland
IT	Italy
JP	Japan
KE	Kenya
KG	Kyrgyzstan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
KZ	Kazakstan
LC	Saint Lucia
LI	Liechtenstein
LK	Sri Lanka
LR	Liberia
LS	Lesotho
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Republic of Moldova
MG	Madagascar
MK	The former Yugoslav Republic of Macedonia
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
MX	Mexico
NE	Niger
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SG	Singapore
SI	Slovenia
SK	Slovakia
SN	Senegal
SZ	Swaziland
TD	Chad
TG	Togo
TJ	Tajikistan
TM	Turkmenistan
TR	Turkey
TT	Trinidad and Tobago
UA	Ukraine
UG	Uganda
US	United States of America
UZ	Uzbekistan
VN	Viet Nam
YU	Yugoslavia
ZW	Zimbabwe

METHOD AND APPARATUS FOR FEEDING MATERIAL INTO A ROTATING MOULD

The present invention relates to apparatus for and a method of rotational moulding.

Rotational moulding is a plastic processing technique used to manufacture hollow plastic objects. A pre-weighed shot of material, determined by the desired wall thickness of the part, is placed in one half of a hollow sheet steel, cast aluminium or composite mould, which is mounted on a bi-axially rotating arm. The mould halves are closed and clamped together. The arm then moves into the oven where it is rotated usually bi-axially to create a directed distribution of material on the internal surface of the mould. After the plastic has fully melted and consolidated, the arm moves out of the oven, into a cooling area, while still rotating bi-axially. Once the plastic has solidified and the mould is sufficiently cool to handle, the mould is unclamped and the part removed.

As previously stated, traditional mould 'charging' (adding the powdered plastic to the mould), involves weighing out an amount of material and pouring it into the mould. The mould is then clamped shut and the cycle starts.

It is an object of the invention to improve this traditional mould charging method.

According to one aspect of the present invention, there is provided apparatus for rotational moulding comprising a mould, means enabling the

mould to be moved and means for feeding material to be moulded to the mould during moulding.

According to another aspect of the invention, there is provided a method of rotational moulding including the steps of feeding moulding material to a mould and simultaneously moving the mould in an oven.

In a preferred embodiment of the invention, the means for feeding material to be moulded comprises a feed hopper connected to the mould via a feed line. The movement of the mould may be a bi-axial rotation but other types of movement such as full or partial rotation about one axis or any combination of these may also be used. The feed hopper is connected to a source of pressure, advantageously compressed gas such as air, via a pipe which incorporates control valves. Powdered moulding material is thereby carried on a stream of air under pressure to the mould. Liquid or granular material may also be used and a vacuum may be used to pull the material along rather than pressure to push it. The pressure or vacuum may be steady or variable. For example, it may be pulsed. The feed line incorporates rotatable joints enabling rotation of the mould about the two transverse axes in relation to the surrounding. It also includes an insulated section to insulate the material passing through while in the mould and a separating device which serves as a cyclone relieving air pressure in the system while at the same time directing polymer powder into the mould. Joints and feed line used may be those already fitted to some industrial

rotational moulding machines.

In order that the invention may be more clearly understood, one embodiment thereof will now be described, by way of example, with reference to the single figure of the accompanying drawing which shows one form of rotational moulding apparatus according to the invention.

Referring to the figure, the apparatus comprises a carriage 1 mounted on wheels 2. Mounted on and extending from the front face of the carriage is a support 3 for a mould 4. The support 3 comprises an arm which is rotatably mounted for rotation about a horizontal axis 5. The mould 4 is mounted on the arm 3 for rotation about a vertical axis 6. In this way biaxial rotation of the mould 4 is provided for with respect to the carriage 2. Several moulds may be mounted on the same arm of any appropriate material such as sheet steel or cast aluminium. Composite materials may be used. Other types of movement than biaxial rotation may be employed, such as full or partial rotation about one axis or a combination of both. The objective is to create a desired distribution of material on the internal surface of the mould.

A material feed line 9 extends from a material feed hopper 10 through the carriage 1 and the support 3 to the mould 4. A valve 11 is disposed in this line just downstream of the feed hopper 10. The line comprises a flexible pipe 12 which leads into a rigid section 13 which extends through the carriage 1. From the trolley the line extends into the arm 3 and through

a rotating joint 14 into an insulated section 15 of inverted J-shape at the other end of which is disposed a further rotating joint 16. On the downstream side of this rotating joint 16 is a separating device 17 and leads to a mould/system interface 18 which leads into the mould 4. The inverted J-shaped section is provided with a system support and enclosure 19.

A compressed gas (such as air) system comprising a compressed gas supply (not shown) is provided to pressurise the material in the feed hopper 10 from which polymer powder is fed at a controlled rate into a pressurised air stream. The gas supply is connected via a valve 20 to a pipe 21 which is connected at opposite ends respectively to the top of the feed hopper and to the valve 11 on the downstream side. Isolator valves 22 and 23 are connected on opposite sides of the junction of the downstream side of valve 20 and pipe 21 and a non-return valve 24 is connected in pipe 21 adjacent to the junction of this pipe with the downstream side of valve 11. The gas stream thereby provided in use carries material from the hopper under pressure through the feed pipe 9 into the mould while the mould is rotated biaxially about axes 5 and 6 inside an oven (not shown) into which the mould is advanced by the carriage 1. The cyclone separator unit is operative to relieve gas pressure in the system while at the same time directing the polymer powder into the mould.

The pipework and rotatable joints used may be those existing in some industrial rotational moulding machines for pressuring the mould or for

ducting an inert gas into the mould. Note that the plastic material may have its temperature controlled on the way to the mould.

There are a number advantages associated with this type of system:-

Elimination of the material charging stage - This minimises any risk to operatives from inhalation or dust explosions, as well as improving general tidiness in the moulding environment.

Multi-layer materials - Previously, creating multi-layered mouldings involved having to reverse the mould out of the oven and load a second shot (stopping both heating and rotation for this period), or the use of a 'drop box' which holds the second shot inside the mould and is remotely activated at the appropriate time (this however only allows one extra shot of material to be added).

Faster cycles - As well as the time increase associated with not having to charge the mould at the beginning of the cycle, the heating cycle is shortened as the polymer is added gradually (as opposed to having a single mass of polymer which is difficult to heat, due to the poor thermal conductivity of the plastic).

It will be appreciated that the above embodiment has been described by way of example only and that many variations are possible without departing from the scope of the invention. For example, although the invention has been shown applied to an offset arm machine it may be applied to any type of rotational moulding machine such as a straight arm

machine. Other types of moulding material may be used for example, ceramic slurry or chocolate. The moulding material may be powdered, liquid or granular. Glass fibres may be fed to the mould. Although the moulded article will usually be removed from the mould after moulding, the mould could form part of the final product. For example, the final product may comprise a metal shell coated with plastic. Vacuums may be used to pull the material into the mould rather than pressure to push it. The vacuum or pressure may be constant or may vary, for example it may be pulsed.

CLAIMS

1. Apparatus for rotational moulding comprising a mould (4), means (3) enabling the mould to be moved and means (10) for feeding material to be moulded to the mould (4) during moulding.

2. Apparatus as claimed in claim 1, in which the means for feeding material to be moulded comprises a feed hopper (10) connected to the mould.

3. Apparatus as claimed in claim 2, in which the feed hopper (10) is connected to a source of pressure to push material from the hopper (10) to the mould.

4. Apparatus as claimed in claim 3, in which the feed hopper (10) is connected to the source of pressure via a pipe (21) including a control valve (20) to provide means to for conveying moulding material to the mould on a stream of fluid.

5. Apparatus as claimed in claim 2, in which a source of vacuum to pull material from the feed hopper (10) and supply it to the mould (4).

6. Apparatus as claimed in claim 5, in which the feed hopper (10) is connected to a source of vacuum via a pipe (12) including a control valve (10) to provide means for conveying moulding material to the mould (4) on a stream of fluid.

7. Apparatus as claimed in any of claims 3 to 6, in which the means (10) for feeding material to be moulded comprises means for maintaining the

pressure or vacuum steady.

8. Apparatus as claimed in any of claims 3 to 6, in which the means (10) for feeding material to be moulded comprises means for pulsing the pressure or vacuum.

9. Apparatus as claimed in any preceding claim, in which the means (10) for feeding comprises a feed line (12) incorporating rotatable joints (14,16).

10. Apparatus as claimed in any preceding claim, in which the means for feeding comprises a feed line (12) having an insulated section (15) to insulate material passing therethrough while in the mould (4).

11. Apparatus as claimed in any preceding claim, in which the means (10) for feeding comprises a separating device (17) serving as a cyclone relieving air pressure in the system whilst directly moulding material to the mould (4).

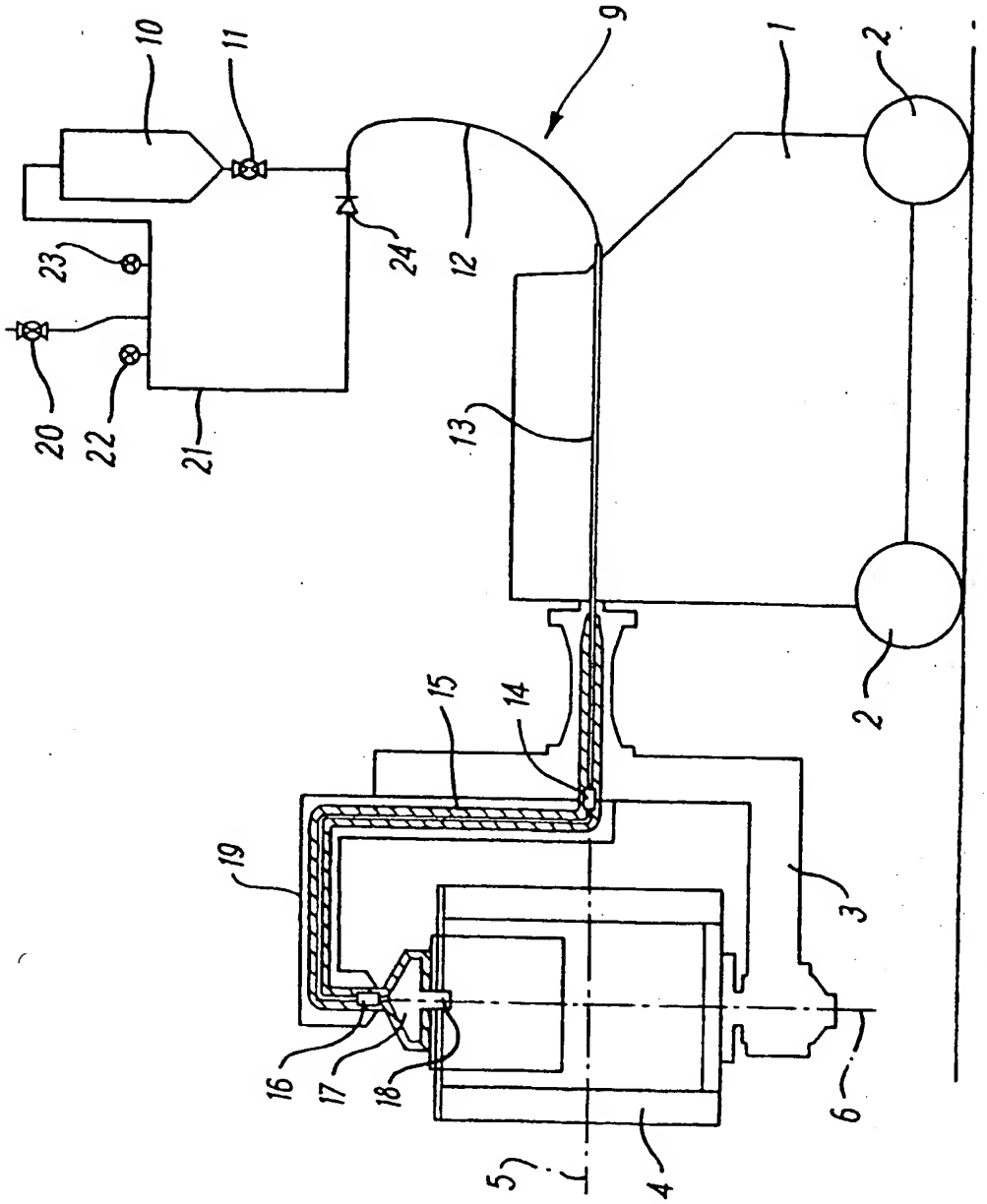
12. Apparatus as claimed in any preceding claim, in which the means (3) enabling the mould to be moved comprises means for producing a triaxial rotation.

13. Apparatus as claimed in any preceding claim, in which the means enabling the mould to be moved comprises means for producing full or partial rotation about one axis.

14. A method of rotational moulding including the steps of feeding moulding material to a mould and simultaneously moving the mould in an oven.

15. A method as claimed in claim 14, in which the mould is rotated fully or partially about an axis.

16. A method as claimed in claim 14, in which the mould is rotated about two axes.



INTERNATIONAL SEARCH REPORT

Inte ional Application No
PCT/GB 98/03758

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B29C41/36 B29C41/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	AU 42099 96 A (AUTOMATED PLASTIC SYSTEMS PTY) 25 July 1996 see the whole document ---	1-4,7, 9-11, 13-16
X	WO 96 16784 A (PAYNE LEROY) 6 June 1996 see the whole document ---	1-4,7, 12-16
X	GB 1 128 608 A (DUNLOP COMPANY LTD) 25 September 1968 see page 3, line 38 - line 124 ---	1-3,7, 13-15
X	FR 2 302 179 A (HALM RICHARD) 24 September 1976 see the whole document --- -/--	1-4, 13-16

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 April 1999	26/04/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Mathey, X

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Int. ional Application No
PCT/GB 98/03758

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 006, no. 263 (M-181), 22 December 1982 & JP 57 157732 A (HITACHI ZOSEN KK), 29 September 1982 see abstract; figure ---	1-4,7, 13-15
X	GB 1 184 717 A (GKN SANKEY LIMITED) 18 March 1970 see the whole document -----	1-3, 13-16

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. ional Application No
PCT/GB 98/03758

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
AU 4209996 A	25-07-1996	AU 691708 B	21-05-1998
WO 9616784 A	06-06-1996	US 5503780 A	02-04-1996
		AU 2595495 A	21-12-1995
		AU 2639995 A	21-12-1995
		AU 4142096 A	19-06-1996
		CA 2187325 A	07-12-1995
		CA 2187327 A	07-12-1995
		WO 9532852 A	07-12-1995
		WO 9532854 A	07-12-1995
		US 5705200 A	06-01-1998
GB 1128608 A		BE 674595 A	15-04-1966
		DE 1479104 A	30-04-1969
		FI 46819 B	02-04-1973
		FR 1462055 A	22-02-1967
		JP 49000340 B	07-01-1974
		NL 6517010 A	04-07-1966
		SE 322903 B	20-04-1970
FR 2302179 A	24-09-1976	DE 2508486 A	02-09-1976
		AT 695475 A	15-07-1979
		CH 590722 A	31-08-1977
GB 1184717 A	18-03-1970	NONE	